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(19)

(54) PLASTIC MOULDINGS

(71) We, GKN SANKEY LIMITED, a British Company of Albert Street Works, Bilston in the County of Stafford, and ARO PLASTICS DEVELOPMENT LIMITED (formerly Aro Plastic Building Supplies Limited), a British Company of 32 Old Burlington Street, London W. 1. do hereby declare the invention for which we pray that a patent may be granted to us and the method by which it is to be performed to be particularly described in and by the following statement:—

This invention relates to apparatus for making articles comprising a rigid reinforcement armature embedded or encapsulated in a thermoplastic synthetic resinous material, i.e. plastics material, which is moulded about the reinforcement armature.

In the making of such articles, the plastics material is moulded in a flowable state about the armature at high pressure and it is necessary to hold the armature in position in the mould cavity during moulding to prevent it being displaced by the plastics material as the latter flows into the mould cavity about the armature.

It has been proposed to hold the armature in position in the mould cavity by projections which extend from the walls of the mould cavity and to withdraw these projections during moulding so that the spaces left by the withdrawal of the projections are filled with plastics material. The material is compressed during moulding and expands as the projections are withdrawn to fill the spaces. Thus the armature is held during the initial stages of the moulding by the projections and when the plastics material substantially fills the mould cavity and the viscosity of the plastics material begins to increase due to cooling of the material, the material becomes sufficiently viscous substantially to hold the armature in position during the final stages of moulding so that the projections can be withdrawn.

We have found that in some cases an article produced by this method has witnesses or depressions in its surface where the plastics material had not completely filled the spaces left by the projections as they were withdrawn. We believe that these witnesses or depressions are caused by hardening of the material in contact with, and in the region of, the projections which are normally made of steel.

With thermoplastic material, the mould is cooled to harden the material and the plastics material hardens from the outside, i.e. the mould cavity walls, inwards and from the inside, i.e. the armature, outwards unless the armature has been preheated in which case the hardening from the inside outwards will be delayed. If the plastics material solidifies around the free end of a projection before or as the latter is withdrawn then this solidified material can prevent the whole of the space left by the projection being filled by the material as it expands with the consequent production of a witness or depression as described.

In our Patent Application No. 9672/21 (Serial No. 1,382,583) we have described apparatus for moulding plastics material about a rigid reinforcing armature and comprising relatively movable mould parts arranged to provide a mould cavity; projections movably mounted on one or more of said parts, actuating means for moving the projections between operative positions in which they project into the cavity and can locate the armature therein and inoperative positions in which they are retracted from the cavity; first means in said parts to abstract heat from the cavity by transfer of heat through the walls of the cavity; and second means associated with said projections to control the transfer of heat along the projections so that such latter transfer abstracts heat at a rate less than said former transfer or is such as to pass heat into the cavity. Such apparatus is hereinafter referred to as being "apparatus of the kind specified."

In said prior application we have described that heat can be supplied to the projections by having a heating element in each projection supplied by wires which lead from

the heating element to an external source of supply. Alternatively, there may be provision for passing heated fluid through the projections and this requires the use of flexible pipes. These wires or pipes must be arranged so as to be able to accommodate the movement of the projections.

While the arrangement described in said application is satisfactory, there are practical difficulties in providing the above mentioned flexible wires or pipes and it is an object of the present invention to provide an improved apparatus which overcomes this difficulty.

According to the present invention we provide apparatus of the kind specified wherein said second means associated with each of said projections comprises a first element arranged to receive energy from an external source and mounted in a fixed position on one of said mould parts and a second element constituting, or carried by, the projection and thus movable relative to the first element as the projection moves, the elements being such that transfer of energy can take place from the first element to the second element to heat the projection without any direct physical connection between the first and second elements.

By this arrangement, the need to connect flexible wires or pipes to each projection is avoided. It is only necessary to connect wires or pipes to the first elements and since these are fixed on a mould part the connection is much simplified.

Various arrangements may be used. Thus the first elements can be heating coils within which the projections move, the projections constituting the second elements. The heating coils may be electrical resistance heating coils or coils supplied with hot fluid.

In another arrangement, the first elements can be induction coils which are supplied with electrical energy and which heat the projections by electro-magnetic induction, here again, the projections constitute the second elements.

In either of these arrangements, each projection may constitute, or may have contained therein, a heat pipe so that the heat supplied by the heating coil or induction coil to the heat pipe is rapidly transferred along the heat pipe to the part of the projection which is in the mould cavity.

As is well known, a heat pipe comprises a pipe containing liquid and a wick. If one end of the pipe is heated, the liquid vaporises and heats the other end of the pipe where the vapour is condensed and fed back to the one end by the wick.

In a further arrangement, each first element may be primary winding of a transformer which is magnetically linked to a secondary winding on a projection which in turn is connected to an electrical resistance heating element within the projection. Energisation of the primary winding of the transformer will thus heat the projection without these being any direct physical connection between the first element constituted by the primary winding and the projection. In this arrangement the secondary winding and the resistance heating element together constitute the second element.

When using tansformer windings, each projection may also include a heat pipe and in such a case the secondary winding of the transformer will be connected to a resistance heating element which heats one end of the heat pipe and the other end of the heat pipe will be arranged to transfer heat to the end of the projection which is within the mould cavity.

In some embodiments, due to the relative movement between the first and second elements there will be some variation during movement of the projections in the heating effect. Where the first element is the primary winding of a transformer there will obviously be some variation in the magnetic linkage as the projection moves between its operative and inoperative positions.

This variation in magnetic linkage may be employed to vary the heating effect as required by the manufacturing process. For example, when the projection is fully projected into the mould cavity, i.e. in its operative position, the electro-magnetic linkage may be at a maximum so that the projection is at is maximum temperature whereas when the projection is withdrawn from the cavity the linkage may decrease whereby the temperature of the projection will fall.

In other embodiments, e.g. using a resistance heating coil to heat the projection directly there may be a constant rate of heat input to the projection both in its operative and inoperative positions if this is found to be desirable in practice.

Various arrangements embodying the invention will now be described in detail by way of example with reference to the accompanying diagrammatic drawings in which each of Figures 1 to 3 is a diagrammatic cross section through a mould part showing a projection mounted therein.

Referring first to Figure 1, a mould part is indicated generally at 10 and a projection at 11. The projection is mounted in a bore 12 in the mould part for movement parallel to the longitudinal axis of the projection by means which is not shown. The projection is shown in its operative position in which the end portion 13 of the projection is within a mould cavity 14. The end portion 13 is adapted to engage a reinforcement armature, not shown, in the cavity 14 while the armature is encapsulated in thermoplastic material such as PVC and the projection is then to

be withdrawn so that the end surface 15 is flush with the wall 16 of the mould cavity so that the space left by the withdrawal of the projection can be filled with thermoplastic material.

In a bore 17 in the mould part 10 is provided an induction winding 18 which may be supplied with electrical energy from an external source, not shown. The projection 11 is heated by electro-magnetic induction from the coil 18. It will thus be seen that it is not necessary to provide any flexible wires to the projection 11 itself.

In a first modification of the arrangement shown in Figure 1, a heat pipe may be provided within the projection so that one end is heated by the coil 18. The coil 18 may be replaced by a heating coil, for example an electrical resistance coil or a coil through which hot fluid is passed and such a coil may heat the end portion 19 of the projection directly or a heat pipe may be provided within the projection as described.

Referring now to Figure 2, a mould part is indicated at 20 in which is slidable a hollow projection 21 so that the end portion 22 thereof may project into a cavity 23 as shown. Mounted within the projection 21 is an electrical resistance heater 24 the ends of which are connected to the secondary winding 25 of the transformer which surrounds the end portion 26 of the projection. The primary winding of the transformer is indicated at 27 and is received in a bore 28 in the mould part 20. Here again it will be seen that the pojection 21 can be heated without there being any direct physical contact between the windings 25 and 27, electrical energy supplied to the winding 27 causing a current to flow through the heater 24 and thus heat the projection 21.

Referring now to Figure 3, this shows a modification of the arrangement shown in Figure 2 in which the projection contains a heat pipe. The projection is indicated generally at 29 and contains a heat pipe 30 containing a wick 31. The heat pipe is of substantially the same length as the projection. One end portion 32 of the heat pipe is surrounded by an electrical heating coil 33 whose ends are connected to the secondary winding 34 of a transformer. The primary winding 35 of the transformer is mounted in a bore 36 in a mould part 37. It will be apparent that electrical energy supplied to the winding 35 will cause the right hand end of the heat pipe 30 to be heated which will vaporise the liquid therein which will travel to the left hand end of the heat pipe where it will condense and will then move to the right hand end of the heat pipe along the wick 31. The heat pipe increases the effective thermal conductivity of the projection 29 so that heat applied from the heating coil 33 is rapidly transmitted to the left hand end of the projection.

It will be apparent in the embodiments using transformer windings that the effectiveness of the transfer of energy from the first element to the second element will vary as the projection is moved longitudinally. This variation may be employed usefully in varying the heating of the projection as it is moved in accordance with the steps of the process.

The supply of heat to the projections will delay the solidification of the thermoplastic material in the neighbourhood of the projections so as to ensure that when the projections are withdrawn the material in the vicinity of the projection ends is sufficiently fluid to flow into the cavities left by the withdrawal of the projections.

WHAT WE CLAIM IS:—

1. Apparatus of the kind specified wherein said second means associated with each of said projections comprises a first element arranged to receive energy from an external source and mounted in a fixed position on one of said mould parts and a second element constituting, or carried by, the projection and thus movable relative to the first element as the projection moves, the elements being such that transfer of energy can take place from the first element to the second element to heat the projection without any direct physical connection between the first and second elements.

2. Apparatus according to Claim 1 wherein the first elements are heating coils within which the projections move and constitute the second elements.

3. Apparatus according to Claim 2 wherein the heating coils are electrical resistance heating coils.

4. Apparatus according to Claim 2 wherein the coils are arranged to be supplied with hot fluid.

5. Apparatus according to Claim 1 wherein the first elements are induction coils arranged to be supplied with electrical energy, the projections constituting the second elements and being heated by electromagnetic induction.

6. Apparatus according to Claim 1 wherein each element is the primary winding of a transformer which is magnetically linked to a secondary winding on a projection which in turn is connected to an electrical resistance heating element within the projection, each resistance heating element and its associated secondary winding constituting a second element.

7. Apparatus according to any preceding claim, wherein each projection includes a heat pipe to transfer heat to the part of the projection which is within the mould cavity

when the projection is in its operative position.

8. Apparatus according to Claims 6 and 7 wherein each resistance heating element is arranged to heat one end of a heat pipe.

9. Apparatus according to Claim 1 wherein there is a variation in the rate of energy transmission between each pair of first and second elements as the associated projection moves between its operative and inoperative positions and is at a maximum when the projection is in its operative position.

10. Apparatus of the kind specified substantially as hereinbefore described with reference to and as shown in Figure 1 of the accompanying drawings.

11. Apparatus of the kind specified substantially as hereinbefore described with reference to and as shown in Figure 2 of the accompanying drawings.

12. Apparatus of the kind specified substantially as hereinbefore described with reference to and as shown in Figure 3 of the accompanying drawings.

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1 SHEET

FIG1

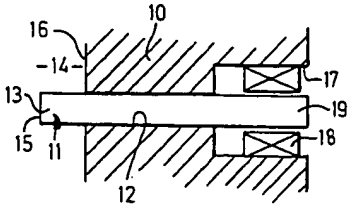

FIG2

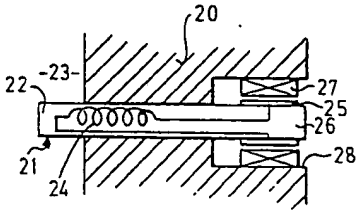

FIG3